## XX.—*On the Development of* Neritina fluviatilis.

By E. Claparède*.

The capsules, which are usually taken for the eggs of the *Neritinæ*, are round balls, a little flattened on one side, 0·7–1 mill. in diameter, enclosed in a hard shell, which has been described as calcareous, but which does not effervesce with acids. They consist of two segments, firmly united at first, but readily separable afterwards; the upper one is larger, and forms a hemispherical dome; the other is of a flatter form, and resembles a bowl. Each female attaches her eggs to the back of her neighbour, but not to her own. In the neighbourhood of Berlin this is not the case, but the capsules are usually attached to stones, or, where these are wanting, to the shells of *Dreissenæ* and other Mollusca. When the capsules dehisce, the lower segment remains attached, and this has given rise to an erroneous opinion that the capsules corrode the surface of the shell, producing small indentations: this appearance is caused by the raised margins of the lower segments.

The capsules consist of two membranes, not easily separated: the inner one is delicate, perfectly colourless, transparent and structureless; the outer thick, yellow and opake. The outer membrane of the upper segment has sometimes an appearance of cellular structure, which is due to adherent Diatomaceæ: the outer membrane of this part exhibits no recognizable structure; that of the lower segment, however, shows a reticulated structure, caused by round or oval spaces separated by darker intervals. These are not cells, but lighter and probably thinner spots in the capsule. Their diameter varies from 0·006 to 0·04 mill.

The margins of the segments possess a horizontal border, like the rim of a plate, 0·06 mill. in breadth; these two borders are in contact. Their surfaces are finely striated or furrowed, and the adherence of the segments is doubtless caused by the raised lines on the rim of one segment fitting into the furrows of the other.

In the earliest stage of development observed, the capsules contained from forty-five to sixty or more spheres. These might have been globules of segmentation, as only a single embryo was developed in each capsule; this was originally very

* An abstract of part of M. Claparède's paper "On the Anatomy and Development of *Neritina fluviatilis*," in Müller's Archiv, 1857, pp. 109–248. This abstract is confined to the portion which refers to the earliest development of *Neritina*, as this alone bears upon the opposite views of the development of these Mollusca held by Dr. Carpenter and MM. Koren and Danielssen.—W. S. D.

minute, and gradually increased in size, whilst the yelk-mass disappeared in the same proportion. But they had exactly the appearance of segmented eggs: they were yellow, transparent globules, 0·12–0·07 mill. in diameter, and appeared to be composed of a great many smaller spheres. The latter were perfectly transparent, their surface alone being sparingly sprinkled with small, strongly refractive, vitelline granules. The spheres presented the greatest resemblance to the egg of *Modiolaria marmorata* in the last stage of segmentation, as figured by Lovén. No vitelline membrane could be detected with certainty upon them: when crushed, a sort of empty envelope was obtained, but this deliquesced immediately. The small internal globules (nuclei) presented a distinct contour, but they were not true cells, contained no nucleolus, and, when pressed, broke up like lumps of a gelatinous or fatty substance. Lovén mentions the same thing with regard to the nuclei of *Modiolaria*.

The diameter of the spheres contained in the capsules exactly agreed with that of the mature eggs from the upper part of the oviduct; and it was scarcely probable that in their progress to the vaginal orifice they would acquire fifty or sixty times that bulk. New matter would certainly have exhibited a different nature from the rest of the yelk, but the 45–60 spheres were exactly similar. The capsules were therefore to be regarded as containing numerous eggs.

The development of the single embryo in this case could not take place in the way described by Koren and Danielssen, as the smallest embryos were not much larger than the segmented eggs, so that the embryo must be formed in accordance with the ordinary law, from a single egg. The embryo in the period of rotatory movement is a round creature, ciliated on its whole surface, with a diameter of 0·112 mill., or about the same as that of a moderate-sized egg. It turned round within the vitelline membrane, which was now distinct, although soft; its contents formed an opake coarsely granular mass, a sort of emulsion of larger or smaller fatty drops, in which the peripheric layer was not clearly perceptible, probably from its being very thin. In most known larvæ of Mollusca, the rotating embryo is clothed with cilia, which are either produced beneath the vitelline membrane, through which they afterwards penetrate, or formed upon that membrane itself; in *Cardium*, however, according to Lovén, the same thing occurs as in *Neritina*. The only embryo seen in this condition died before breaking through the vitelline membrane.

The embryo developed from one egg devours the other eggs, as was stated by Carpenter, in opposition to Koren and Danielssen, to be the case in *Purpura*. In *Purpura*, as in *Neritina*, all the

spheres undergo segmentation, but they are not surrounded by a peculiar membrane. There is no perceptible difference between them; and in *Neritina* no such distinction in the mode of segmentation as that discovered by Busk in *Purpura*, was to be seen. The only difference is in their ultimate destiny; and it appears probable that the genesis of both structures is the same, as the segmentation of the "egg-like bodies" is in favour of their being true eggs; and the distinction observed by Busk may not be of great importance, as it is asserted only that many of the "egg-like bodies" contained in the capsule exhibit a very marked irregularity in the first segmentation; so that it is not impossible that the others might have presented the same thing less distinctly; and, moreover, there is no certain proof that the former were really the so-called true eggs. All the eggs in the capsules both of *Neritina* and *Purpura* may therefore be regarded as genuine eggs, but how most of them are arrested in their development still remains a mystery.

When the abortive spheres in the capsules of *Purpura* have undergone segmentation, they exhibit a decided tendency to become amalgamated, and adhere to each other with such tenacity, that they cannot be separated without difficulty; finally, their boundary-lines disappear entirely, and there remains only a uniform conglomeration of small vitelline segments. This never occurs in *Neritina*. At the time when the embryo makes its appearance, the abortive segmented eggs split up into groups of globules, each of which is about half the size of an entire egg, and sometimes even smaller. These usually consist of one large and numerous smaller yelk-spherules. But there is never even a slight mutual adhesion of these groups, and they remain separate until they disappear by being devoured by the embryo.

The observation of the different stages of development was rendered difficult by the opacity of the capsules, which required to be opened to enable their contents to be examined, and by the fact that the *Neritinæ* do not lay their eggs in captivity, probably because the still water does not suit them. The smallest embryos detected, which had completely lost their ciliary coat, formed an irregular cylinder, divided into two parts by a circular notch; these parts may be distinguished as "cephalic" and "abdominal," names employed by Vogt in *Actæon*. The cephalic portion bears an elevation on its dorsal surface, forming a more or less distinct oval swelling, beset with very delicate cilia. This is the first trace of the velum. Close before it, at the anterior end of the animal, is a shallow impression,—the mouth. Immediately below this a disciform organ soon makes its appearance, which is at first very narrow and short, but gradually increases in size posteriorly. This is the first indication

of the still inoperculate foot. At this period the internal organs of the abdominal part or true body are not recognizable. The velum very soon increases rapidly, becoming developed like a hem, whilst its margin acquires longer, more distinct, and more numerous cilia. This margin grows considerably thicker in proportion to the membrane of the velum. In the abdomen a spacious cavity is formed, and in this a quantity of formative mass collects as an aggregation of fatty drops of various sizes. The foot forms an oval organ possessing thick walls and an inner cavity which seems to be in connexion with that of the abdomen. The foot is still completely destitute of cilia. The pit-like anterior impression becomes converted into a transverse buccal orifice, which leads into a tubular œsophagus. The entrance into the mouth is ciliated all round, as is the whole surface of the œsophagus. The same thing was seen by other observers in the embryos of many Mollusca.

Thus the alimentary canal makes its appearance in the embryo of *Neritina* as soon as the foot, or perhaps sooner. In *Actæon*, according to Vogt, the alimentary organs are very late in appearing,—much later, for example, than the otolithes and the shell. The same was observed by Sars, Lovén, &c., especially in the Nudibranchiata; and, according to Koren and Danielssen, the formation of the heart in *Buccinum* precedes that of the œsophagus, although this appears improbable, both from Carpenter's statements with regard to *Purpura*, and from what takes place in *Neritina*. In *Neritina* the œsophagus is formed and lined with cilia before the first traces of the auditory and visual organs, the shell, &c., have appeared; and Carpenter met with the same conditions in *Purpura*. Leydig also says that the embryos of *Paludina* are furnished with a mouth and anus, and the foundations of the pharynx and intestine, before any trace of an ear exists.

This early appearance of the alimentary organs is of great importance for the further development of the *Neritina*. From this moment it is no longer a mere immature embryo, but a larva, swimming freely about in the capsule, and feeding upon the remaining contents of the latter, the sister-eggs, which have not arrived at development. This is not a mere assertion, rendered probable by the gradual increase of the minute embryo and the simultaneous disappearance of the rest of the yelk-mass, until the embryo fills the whole capsule,—but a fact proved by observation. If the capsule be opened carefully, the little embryo escapes and swims about amongst the numerous groups of globules already mentioned as formed by the breaking-up of the abortive eggs, which are perfectly transparent and of a pale golden-yellow colour; they consist of a homogeneous, tenacious,

fat-like substance. These globules are enveloped by a thin, colourless layer of a mucous matter, in which extremely fine yelk-granules are imbedded. This is the food of the young *Neritina*. The larva swims about in the water under the microscope, and is soon seen to approach a yelk-mass and give it a revolving motion by means of the cilia of the velum, whilst the animal itself is stationary. By this means the globules are brought to the mouth, not to be swallowed at once, but merely licked away. They are constantly turned before the mouth, whilst the granules of the colourless outer layer are torn away and swallowed by means of the cilia. They pass into the funnel-shaped pharynx, where they are kept in tremulous movement by the cilia, until they reach the abdominal cavity and unite with the accumulation of nutritive material already existing there. Although the yelk-granules of a globule are seen continually passing into the pharynx, their number does not perceptibly diminish; so that one is compelled to suppose that new granules are formed, probably from the transparent yelk-globule, to replace those which are swallowed. This feeding of the young *Neritinæ* in the capsule suffices to explain their great increase of size; for towards the end of its embryonal life the animals have attained forty to sixty times their original volume. Carpenter states that in *Purpura* this feeding can rarely be observed, and only under peculiarly favourable circumstances; in *Neritina* it may be seen with almost every embryo. The young animal sometimes swallowed foreign bodies besides the yelk, when they came within reach of the cilia of the velum: a *Navicula* or a *Synedra* was several times carried into the pharynx. It must be remarked that Koren and Danielssen represent the abdomen in young embryos of *Purpura* and *Buccinum* as filled with an aggregation of yelk, consisting of uninjured eggs, although the œsophagus is too narrow to allow of the passage of these. No eggs are found in the abdominal cavity of embryos of *Neritina* in the corresponding state, but merely an aggregation of larger or smaller granules or drops, agreeing in nature and colour with the vitelline substance. Nevertheless, the nutriment, when swallowed, not very unfrequently cakes together within the embryo in such a manner that similar formations might easily have been mistaken by the Scandinavian naturalists for eggs. Their statements with regard to the original aggregation and fusion of the eggs for the formation of embryos, does not agree with what takes place in *Neritina*; so that Carpenter has probably come nearer to the truth.

It is only after the embryo of *Neritina* has reached a certain size, acquired a mouth and œsophagus, and eaten foreign yelk, that the shell makes its appearance, and soon afterwards the

operculum and organs of the senses show themselves. At this time the velum has reached its greatest development, and it then gradually diminishes. The tentacles first appear as small tubercles close to the eyes, and gradually increase until they form distinct tentacles by the time the animal quits the capsule. When the velum has completely disappeared, and the triturating plate and lingual cartilage have made their appearance, the capsule opens and the little *Neritina* escapes, to live henceforward in freedom. It creeps about upon the *Dreissena* whose shell bore its egg-capsule, and finds upon this the microscopic organisms which now serve for its nourishment instead of its sister-yelks.

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## XXI.—*Observations on* Trachelius ovum, *Ehrenberg*.

By Professor Carl Gegenbaur*.

In the course of last November I met with an Infusorium, which, at the first glance, I took to be *Trachelius ovum*. Of this, however, I soon began to entertain doubts, although I could discover no known form with which there existed any agreement. For this purpose I could only consult Ehrenberg and Dujardin. The outlines agreed with *Trachelius ovum*, and the form of the "intestine" also was in general the same as in that species. The longitudinal series of cilia, however, were far more numerous; and beneath the cuticula, in the walls of the body, a great many vesicles, arranged at regular distances apart, lay imbedded: with a moderate magnifying power, these looked almost like nuclei, but they were really contractile organs. I reckoned their number at from 50 to 60. They were not spherical, but discoid; they contracted very slowly, and out of about ten which might be watched at the same time, I never found more than one or two in action. In Ehrenberg's figure of *Trachelius ovum*, something is represented that may be referred to these organs. A little above the middle of the body there is a large, richly ciliated cleft, which I regard as the mouth. It leads by a pouch-like prolongation, which is also ciliated, into a finely granular organ, which passes through nearly the whole length of the animal, and which possesses a very different form in different specimens. This part never lies in the middle of the body, but always nearer to the side on which the buccal slit is situated, where it is also partially amalgamated with the wall of the body. Numerous processes, consisting of hyaline or finely granular substance, issuing from this "intestiniform" organ, penetrate the cavity of

* Translated by W. S. Dallas, F.L.S., from Müller's Archiv, June 1857, p. 9.